Centralia, Washington
Deep Coal Seam CO_2
Sequestration Evaluation – Final Report

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TransAlta

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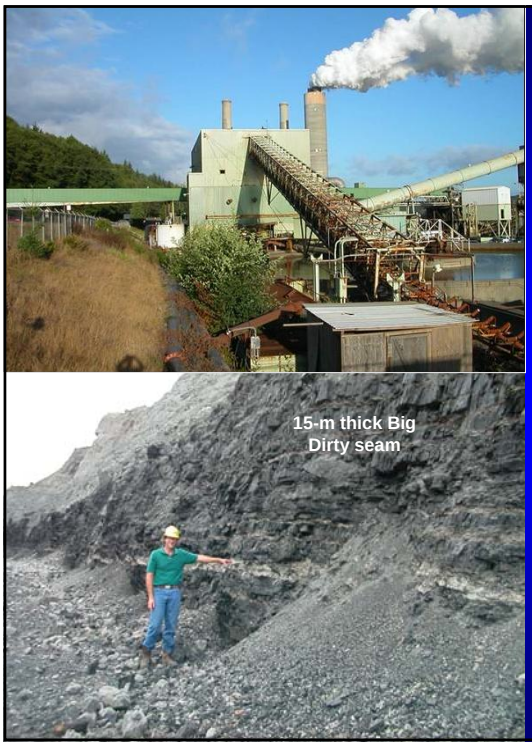

Centralia Power Plant and Coal Mine :

Project Objectives

- ***Evaluate geology and CO_2 storage potential of deep coals and saline aquifer sandstones near the 1400-MW Centralia power plant.***
- ***Develop conceptual reservoir testing program for CO_2 storage at Centralia.***

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Centralia Power Plant and Coal Mine :

Key Conclusions

- ***While not geologically ideal (structurally complex), the Centralia region coals may have 13 years of storage capacity for Centralia power plant (50% storage).***
- ***Sandstones, though generally not of high quality, do have zones with up to 30% porosity and 2 mD of permeability. May add another 9 to 73 years of capacity.***
- ***A well test program with 3-5 coreholes could measure the reservoir properties of coal seams and saline aquifer sandstones at low cost.***

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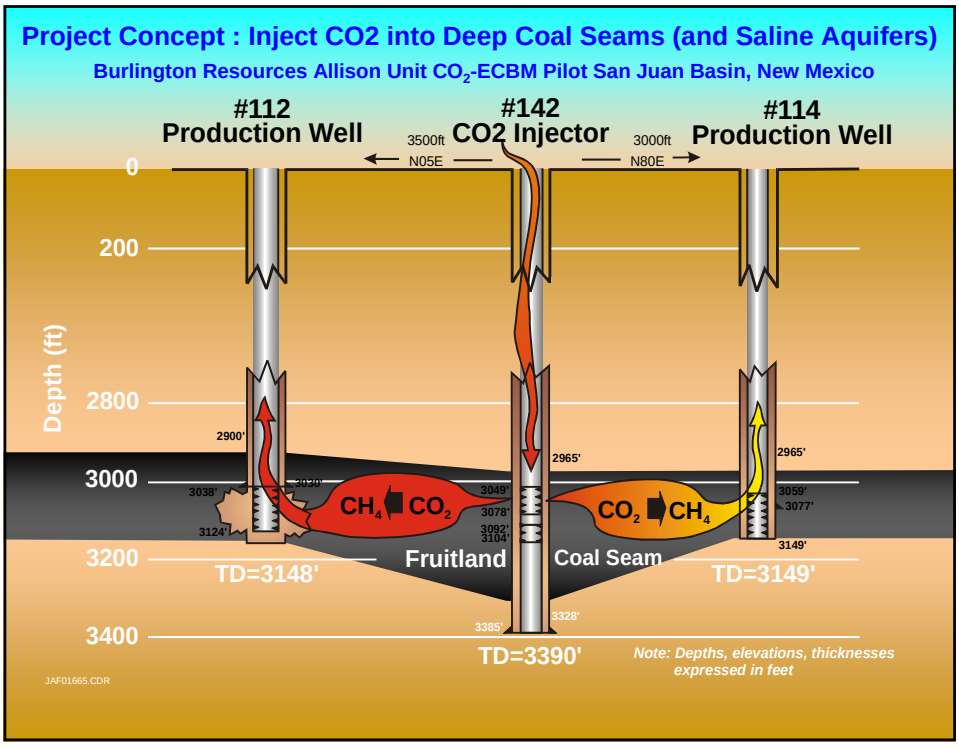

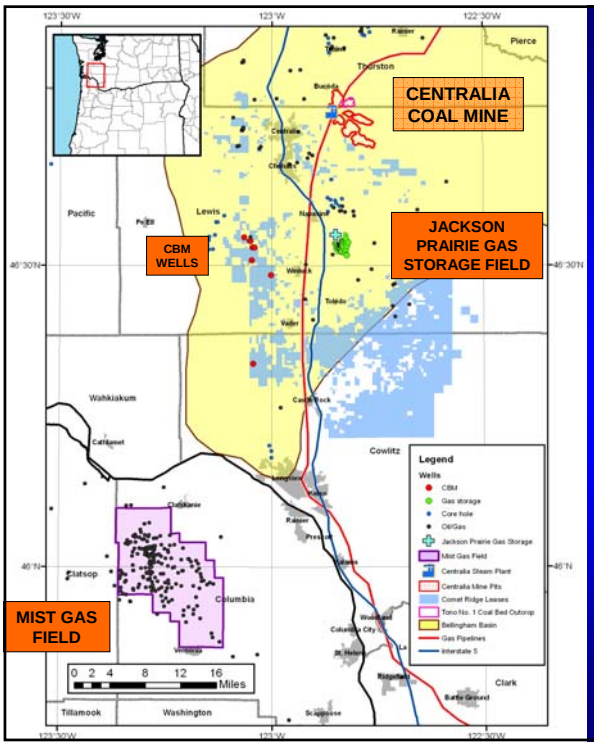

Commercial Analogs

- *Nearby commercial oil and gas activities provide insights for CO_2 storage at Centralia.*
- *CBM exploration wells (red) SW of Centralia suggest coals may have favorable gas content for ECBM.*
- *Jackson Prairie gas storage field (green) south of Centralia utilizes Eocene Skookumchuk sandstones (good P&P) and anticlinal closure. Similar features exist near Centralia.*
- *Mist gas field (purple) in northern Oregon produces and stores gas from Eocene Cowlitz Fm sandstones, similar to those at Centralia.*

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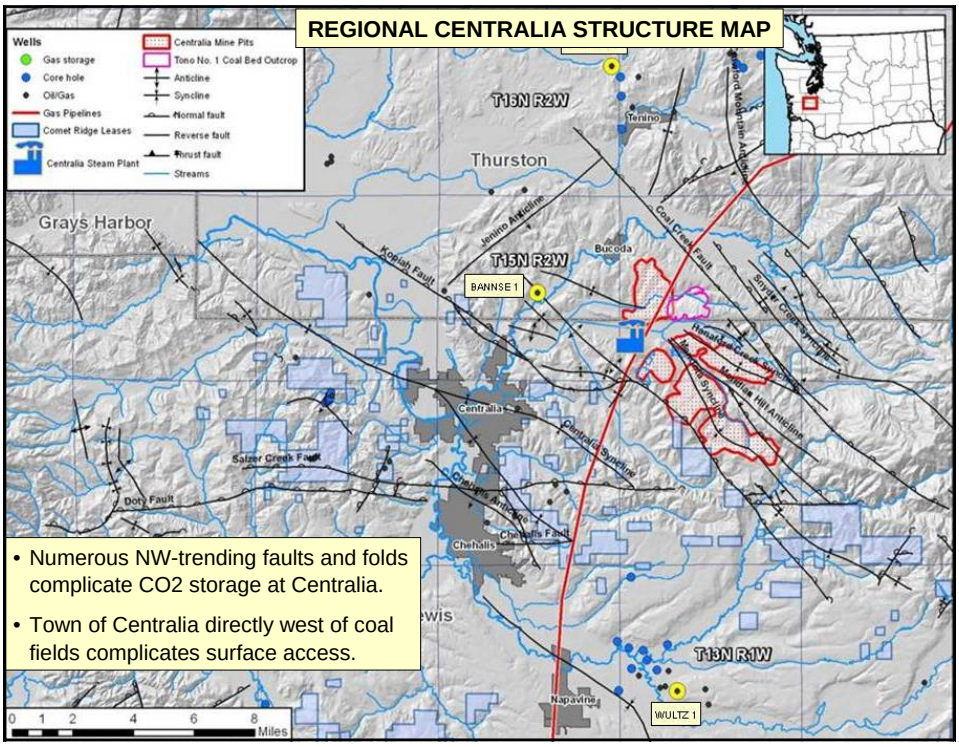
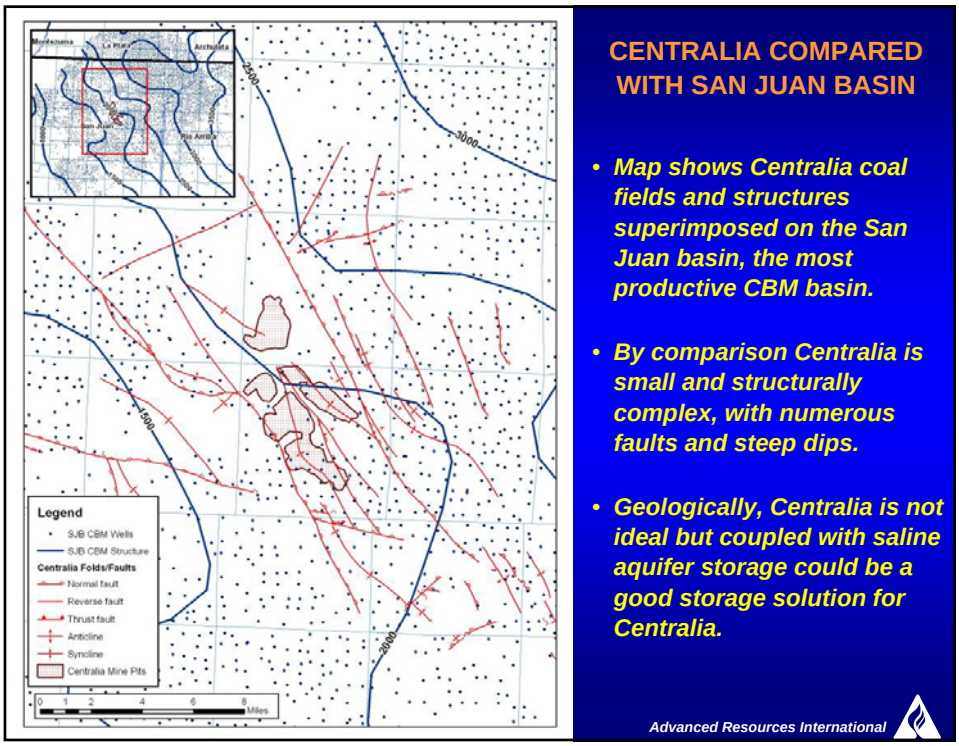

REGIONAL CENTRALIA STRUCTURE MAP
Wells
Gas storage
Core hole
Oil/Gas
Gas Pipelines
Comet Ridge Leases
Centralia Steam Plant
Centralia Mine Pits
Tono No. 1 Coal Bed Outcrop
Anticline
Syncline
Normal fault
Reverse fault
Thrust fault
Streams
T16N R2W
Tenino
Thurston
Grays Harbor
Bucoda
T15N R2W
BANNSE 1
Centralia
Chehalis
T13N R1W
Napavine
WULTZ 1
Miles
• Numerous NW-trending faults and folds complicate CO2 storage at Centralia.
• Town of Centralia directly west of coal fields complicates surface access.


CENTRALIA COMPARED WITH SAN JUAN BASIN
• Map shows Centralia coal fields and structures superimposed on the San Juan basin, the most productive CBM basin.
• By comparison Centralia is small and structurally complex, with numerous faults and steep dips.
• Geologically, Centralia is not ideal but coupled with saline aquifer storage could be a good storage solution for Centralia.
Legend
SJB CBM Wells
SJB CBM Structure
Centralia Folds/Faults
Normal fault
Reverse fault
Thrust fault
Anticline
Syncline
Centralia Mine Pits
Miles
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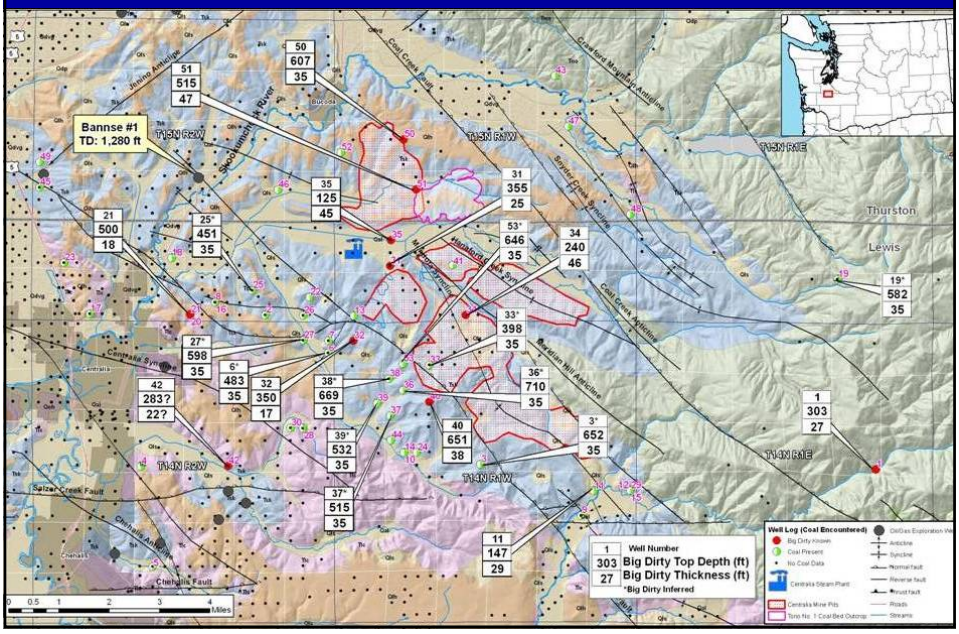
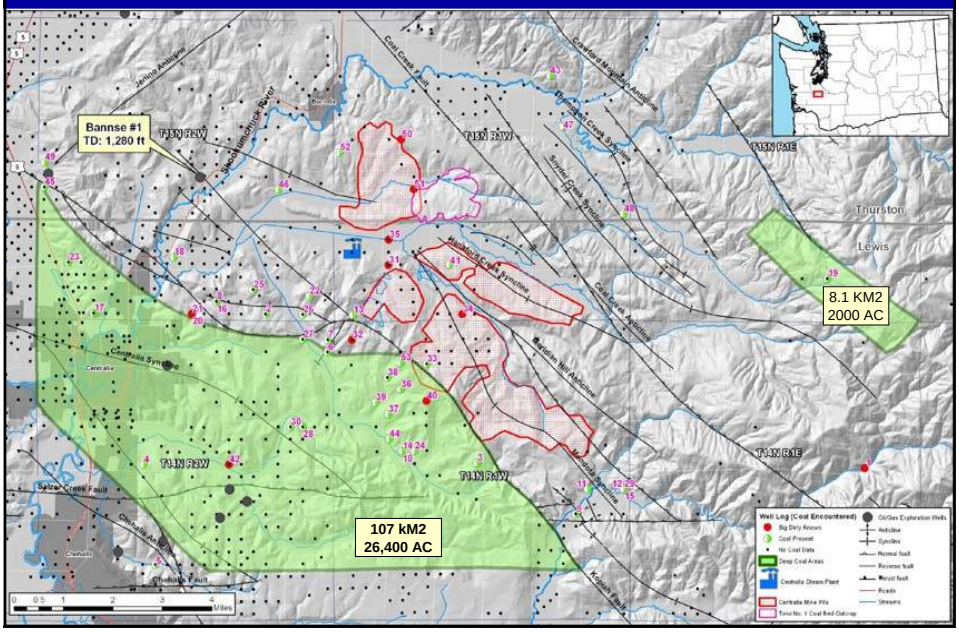
BIG DIRTY SEAM : DEPTH & THICKNESS

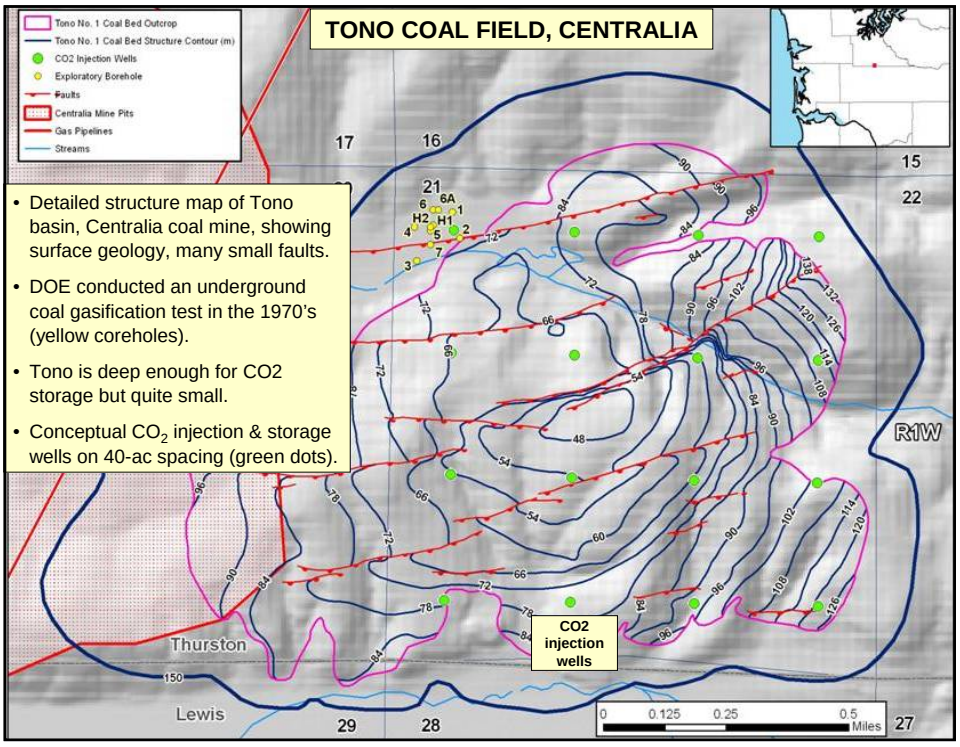
- ***Thickness and depth of the Big Dirty seam near Centralia, within the Eocene Skookumchuck Fm.***
- ***Seam is about 10 m thick and deeper than 150 m in the Centralia syncline west of the coal mine.***



BIG DIRTY SEAM : CO_2 STORAGE AREA

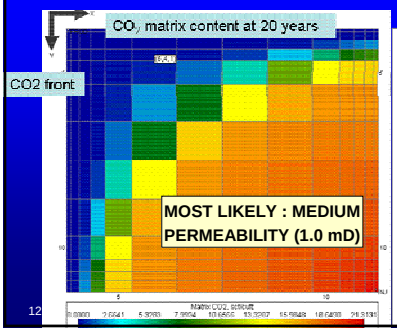
- ***Centralia coal field and adjacent areas (green) where the Big Dirty seam may be deeper than 150 m (500 feet), based on water well logs, and prospective for CO_2 storage.***

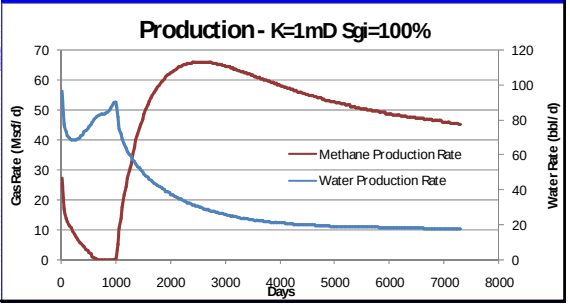




RESERVOIR SIMULATION

- ***Given that coal seam reservoir properties are poorly known at Centralia, reservoir simulation helps evaluate the range of CO_2 injection and CH_4 production behavior as well as optimize well spacing.***
- ***Most Likely case (below) assumed 1 millidarcy of permeability and 100% initial methane saturation.***
- ***Indicates that 40-acre well spacing could be efficient, with CO_2 saturating much of the reservoir over a 20-year injection period. Methane production is modest but might pay back the capex for shallow wells.***
- ***Other sensitivities evaluated alternate perm/saturation assumptions.***





COAL SEAM STORAGE CAPACITY

- ***Deep coal resources in the Centralia region could have about 50 million metric tonnes of storage capacity.***
- ***Assuming 50% capture that would be equivalent to 13.1 years of emissions from the Centralia power plant.***
- ***Saline aquifers in Eocene Skookumchuck Fm and adjacent sandstones could add another 9 to 73 years, for total 22 to 86 years (50% capture).***

Coal Mass	Prospective Area		Depth	Press.	Coal Thickness		Ash	Moisture	Density	Coal Mass Billion daf	
	km^2	acres	m	psi	m	ft	%	%	ton/ac-ft	t	tons
Total Centralia Syncline Prospect	107	26400	500	725	18	59	12	20	1800	1.73	1.91
Adjusted Net 75% Area	80	19800	500	725	18	59	12	20	1800	1.30	1.43

CH_4 and CO_2 Potential	75% Sat.		100% Sat.		100% Sat.		75% Sat		100% Sat.		100% Sat.	
	CH_4 Gas Content (d.a.f.)				CO_2 Content (daf)		CBM Resources				CO_2 Storage Capacity	
	m^3/t	scf/ton	m^3/t	scf/ton	m^3/t	scf/ton	MM m^3	Bcf	MM m^3	Bcf	MM m^3	MM tonnes
Total Centralia Syncline Prospect	4.16	133	5.54	178	21.70	695	7.19	254	9.59	339	37.56	69.82
Adjusted Net 75% Area	4.16	133	5.54	178	21.70	695	5.39	191	7.19	254	28.17	**52.36**

Centralia CO2 Emissions 100%	8.00	million t/yr	6.5	Years storage capacity
Centralia CO2 Emissions 50%	4.00	million t/yr	**13.1**	**Years storage capacity**

Sorption Isotherms:				
	CH4 VL	300 scf/ton daf	CO2 VL	1175 scf/ton
	CH4 PL	500 /psi	CO2 PL	500 /psi

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CONCLUSIONS : TEST COREHOLE PROGRAM AT CENTRALIA

- ***Reservoir properties at Centralia could be moderately favorable for CO_2 storage***
- ***However, coal seam & sandstone reservoir properties have not been tested and require a corehole program to more fully evaluate the CO_2 storage potential.***
- ***Focus on relatively deep narrow synclines near Centralia, where formation pressure is likely to be adequate.***
- ***Full program of coal seam desorption, injection/falloff, and lab testing.***

Activity	Corehole	No.	Total
Permitting	5000	3	15000
Drilling	150000	3	450000
Coring	30000	3	90000
Supervision	20000	3	60000
Well Testing	30000	3	90000
Lab Work	25000	3	75000
Geology	20000	3	60000
Simulation	20000	3	60000
Management	20000	3	60000
Total			**$960,000**

- ***Sandstone core and log evaluation to measure P&P and understand 3D***
- ***Total cost for a basic 3-well program is estimated at approximately $1 million.***

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